Review of Bose PANARAY MA12
A Compact Line-Array Loudspeaker

by David Kennedy

I recently arranged for a Catholic church consulting client to hear how a couple different types of systems (supplied by the factory reps.) would sound in their 1000-seat fan-shaped church. This was done prior to design/modeling, as my modeling software did not have directional data for this model.
I chose contrasting system types to demonstrate, the new Bose MA12 line arrays (dbl. stacked L/R) and Tannoy loudspeakers (4x12" co-axial) in an "exploded" arch. Each system had supplemental LF boxes. The room had a reverberation time of about 3 seconds (not measured).

Summary of evaluation:
This is a great looking, new and very different product. While it has some great virtue and value, it also has some real limitations (that are not intuitive).

The Bose MA12 line arrays had much better direct-sound coverage to the rear of the room than the wider coverage Tannoys. It was amazing how the Bose MA12 line arrays projected speech so clearly above the reverberation of the room. This great clarity was accomplished due to the narrow vertical coverage (lobe) of the Bose MA12s, minimizing echoes off of the ceiling while, significantly improving their throw distance.

While most effective for speech reinforcement, the two pairs of MA12s did have trouble sounding as good for music uses as the Tannoy loudspeakers, due to their frequency response changing with distance (discussed latter).

The church considered acoustic treatment of the room, however, they decided to reorient and EQ their existing Community brand loudspeakers.

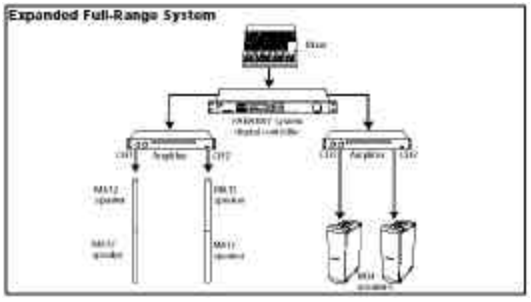

Figure 1. the evaluation system was much like this figure, but with two additional LF units.

Description:
The Bose PANARAY MA12 is a cost-effective and unique-modular line array loudspeaker. As a line array element, this product is designed for use in singles and multiples in permanently installed, indoor applications. The slim profile (5"D x 4"W x 39"H) of the MA12 speaker provides an attractive design element to many installations. The enclosure is made of Aluminum and is available with a White or Black finish.

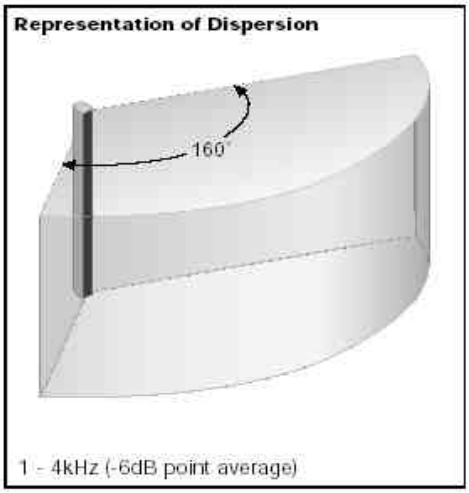

Figure 2. Simplified graphic showing the radiation pattern or coverage angle of a MA12

The MA12 contains twelve 2.2" (5.7 cm) full-range drivers aligned in a vertical line array, wired in series/parallel, resulting in a composite nominal impedance of 8 Ω. The MA12 dispersion is a very wide 160° horizontally, narrowing at high frequencies and very narrow vertically (see figure 4 from Bose this page). This broad coverage and longer throw is much greater than conventional loudspeakers. It is a one-way loudspeaker system, without crossovers or "frequency shading". The MA12 Frequency Range is rated at 155Hz to 12kHz (-3dB), limiting it's use to speech applications without a sub-woofer added to supplement the low frequencies (also available from Bose).

Maximum Acoustic Output (pink noise) is rated at 113dB-SPL @ 1m. Bose Technical Information cautions: *"A single MA12 produces cylindrical waves above 2kHz. Please be careful extrapolating SPL's at greater distances as a true cylindrical source falls off at 3dB per doubling of distance and a conventional spherical source falls off at 6dB per doubling of distance (inverse square law). MA12 speakers can be*

installed end-on-end to create a taller line array. The height of the line array must correspond to the ear height range of the listeners, in sitting and standing positions, in the installation venue."

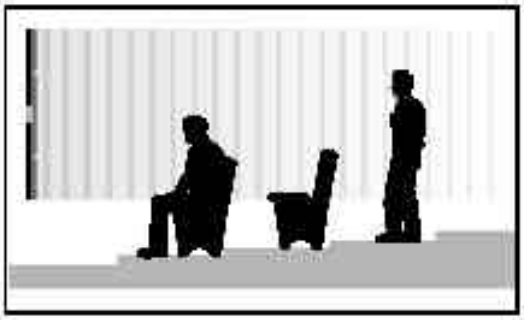

Figure 3 showing the side view of a typical MA12 install

How Line Arrays are Different:
Line array loudspeakers are very popular in the rock touring industry, due to their "long throw" and minimized LF energy spill onto the stage. Bruce Hurst of Bose Corp., Framingham, MA, points out. "*If you look through the trade magazines, you will see that the touring industry has gone to the line array in a big way. The advantage is, now you can hear the poorly-mixed sound as clearly in the back row as you can in the front. The church installation market has started using them also."*

A line array is a group of loudspeaker drivers arrayed in a line, closely spaced, operating with equal level and in phase. Described by Olson in his 1957 classic text, Acoustical Engineering, line arrays are useful in spaces where sound must be projected over a long distance

Line arrays disperse sound differently than conventional loudspeakers. If a line array is long, verses the frequency that it is reproducing, it will have a sound level drop-off, at one-half the typical rate of conventional, point sources. This is a great idea, but low-cost, single-unit, (column shaped) line arrays are not long enough to control low frequencies. This effect causes the rate of fall off to vary with frequency, so then each seat gets a *different frequency response* of direct sound, making it very difficult to design or EQ the system for uniform-good sound.

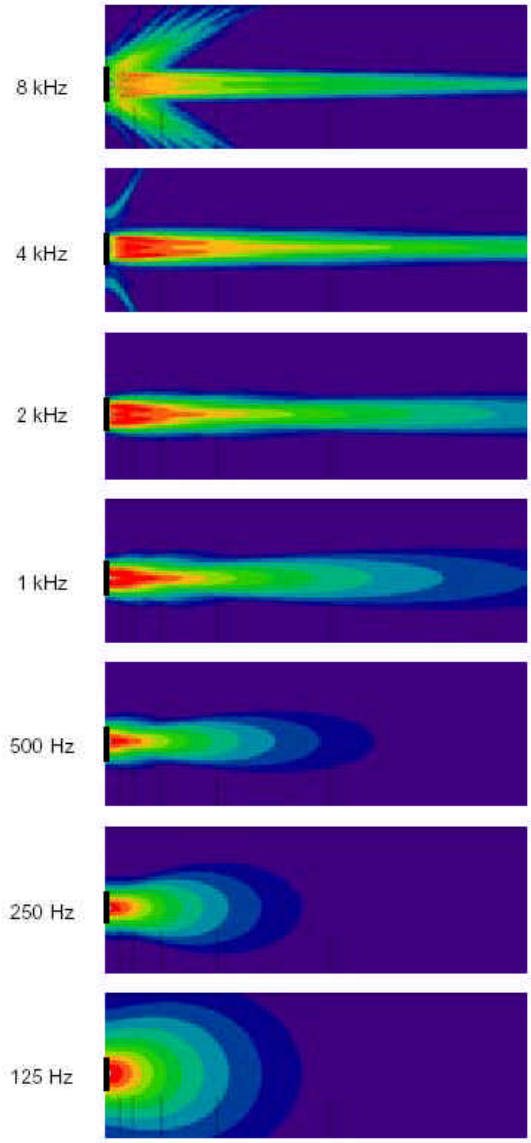

Figure 4. Vertical radiation patterns ("side view") of a stacked pair of MA12s (right) as a function of distance.

Technical Discussion:
For the more technically inclined, following is more detail about the theory behind the Bose MA12 line arrays and how they differ from conventional loudspeaker systems.

Conventional loudspeaker systems, commonly consist of a horn (with a high freq. driver), a woofer driver and a crossover in each enclosure (many pros refer to speakers as boxes). These can also be described as a point-source loudspeaker.

Two-dimensional polar plots and directivity balloons (3D group of polar plots) are commonly used to show the directional (coverage) properties of professional loudspeaker systems. Polar plots describe how much sound radiates from a speaker in a given frequency band and at a given angle. When measured in the far field, polar plots accurately show the radiation pattern at any distance outside the near field.

For a typical point-source loudspeaker, the polar plot at the same at any distance, the only difference is a drop in level. In fact, the level drops by 6dB per doubling of distance. A line array behaves very differently from a point-source speaker. A line array attempts to produce cylindrical waves in the near-field. A cylindrical wave propagates only in a single plane. Therefore, level drops by only 3dB per doubling of distance, and (if arranged vertically) little energy radiates up or down.

Ray A. Rayburn (www.SoundFirst.com) summed up the line-array topic well by explaining, *"Many of the limitations of basic line arrays have been overcome by advanced DSP based arrays. These advanced arrays are currently quite expensive which has limited their use. The technology however is young and new developments are always coming out. With time I expect to see DSP based arrays to drop in price and be used a lot more."*

In a paper published by Morten Jørgensen and Thomas Tyson of Bose, explained: *"Many line array manufacturers, including Bose, agree that the vertical polar plot is dependent on the distance from the speaker and that therefore, simply providing polar plots of a line array at one distance – as for a spherical* [point] *source – does not tell the true story. In fact, using only this data may result in sound system* ***design flaws****.*

*Using a single polar plot is a great way to describe the behavior of conventional (*point-source) loudspeaker*. Using a single polar plot to describe the behavior of line arrays is* ***not*** *sufficient. We find that the following general guidelines are appropriate:*

A single modular MA12 exhibits line array characteristics above about 2kHz within a distance of about 40 feet (13m). Even at lower frequencies there is substantial narrowing of the vertical pattern. A single MA12 is an ideal choice for throws of up to about 40-50 feet (13-16m).

A stacked pair of MA12s exhibits line array characteristics above about 500-1kHz within a distance of about 80 feet (25m). There is substantial narrowing in the vertical pattern down to 250Hz. For throws longer than about 50 feet (16m) and more difficult acoustic spaces, doubling the height of the array, results in significant improvement in clarity, especially at lower frequencies.

Vertical lines using ***three or more*** *MA12s exhibit line array characteristics substantially over the* ***entire*** *frequency range"*

Conclusion:
The Bose PANARAY MA12 is a unique, cost-effective and elegant-looking line-array loudspeaker -- it can even be mounted flush with the wall surface.

Three or more MA12s, along with supplemental woofers, can project direct sound great distances in a reverberant space. The greatest challenge with basic cost-effective line arrays, like the Bose MA12, may be the way that their main lobes get smaller with rising frequency, causing the frequency response to change with distance (this is not a good thing).

Another challenge lies in how to design line-array-based sound systems in modeling programs. Most of the modeling programs are assuming the loudspeaker is a point source, this is untrue when modeling line arrays, so if not done right will yield errors.

David is the founding Consultant at David Kennedy Associates d-k-a.com and Worship Space, providing expert design of Architectural Acoustics, Sound and Display Systems for churches. He can be reached at (559) 435-1122 or dkennedy@d-k-a.com.

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